Experiments with TEL1

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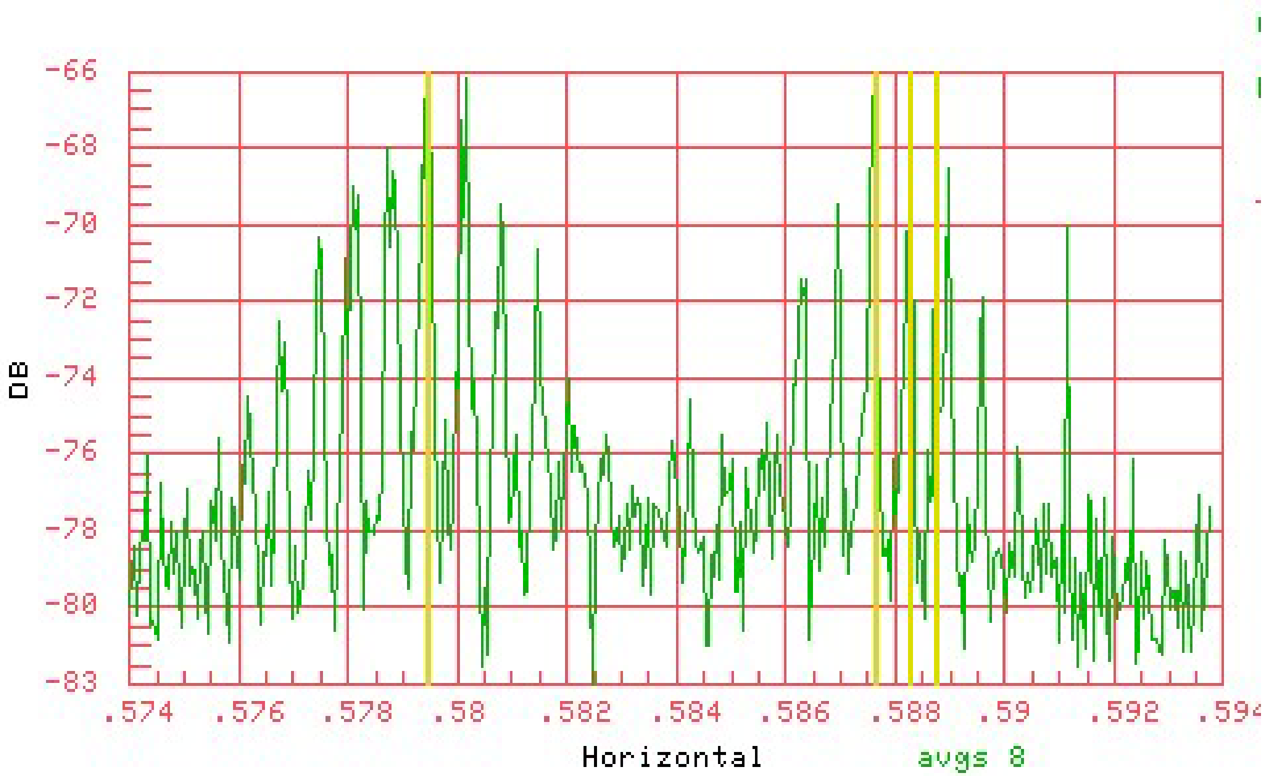
Experiment Categories

- Beam-beam compensation studies
  - Tune shift & beam lifetime vs. electron beam parameters, etc.
- DC beam studies
  - DC beam cleaning efficient, DC beam measurement, calibration of the abortgap monitors, etc.
- Beam diagnostics tool
  - Pbar tune measure by exciting pbar bunches, controlled proton or pbar remover, noise vs. beam emittance growth, etc.

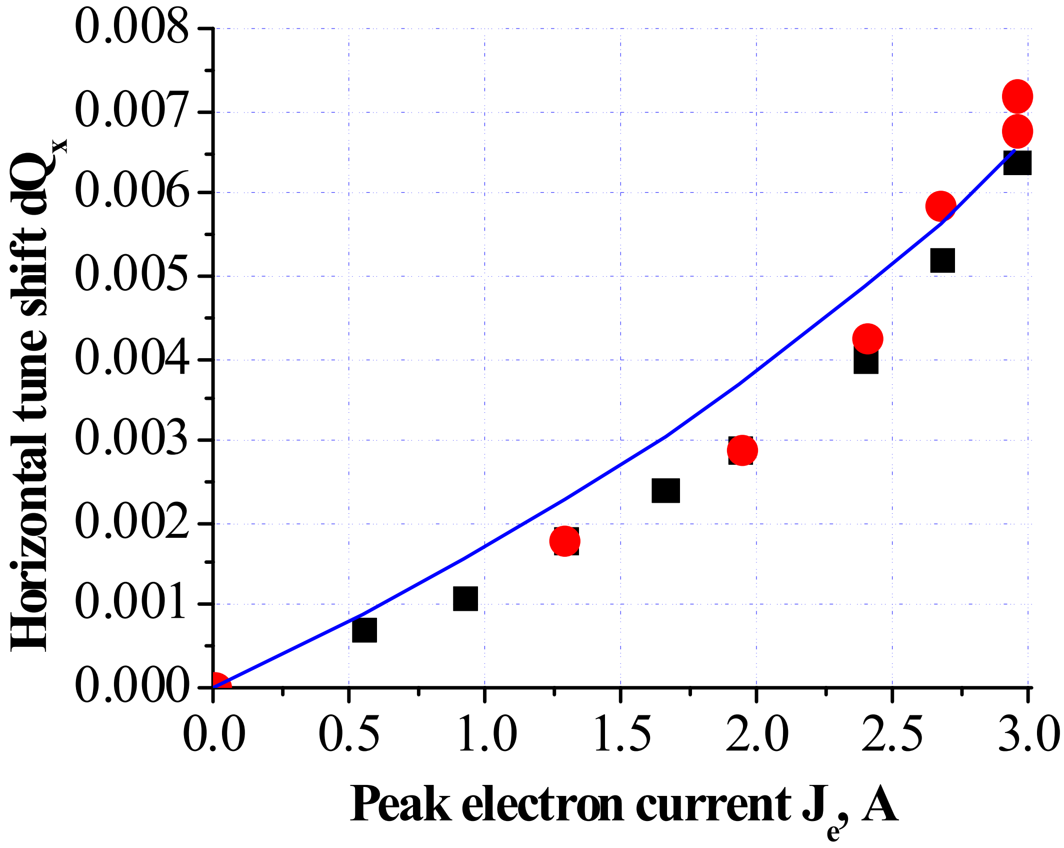
Beam Tune Shift

Three bunches in the Tevatron, the TEL acts on one of them;

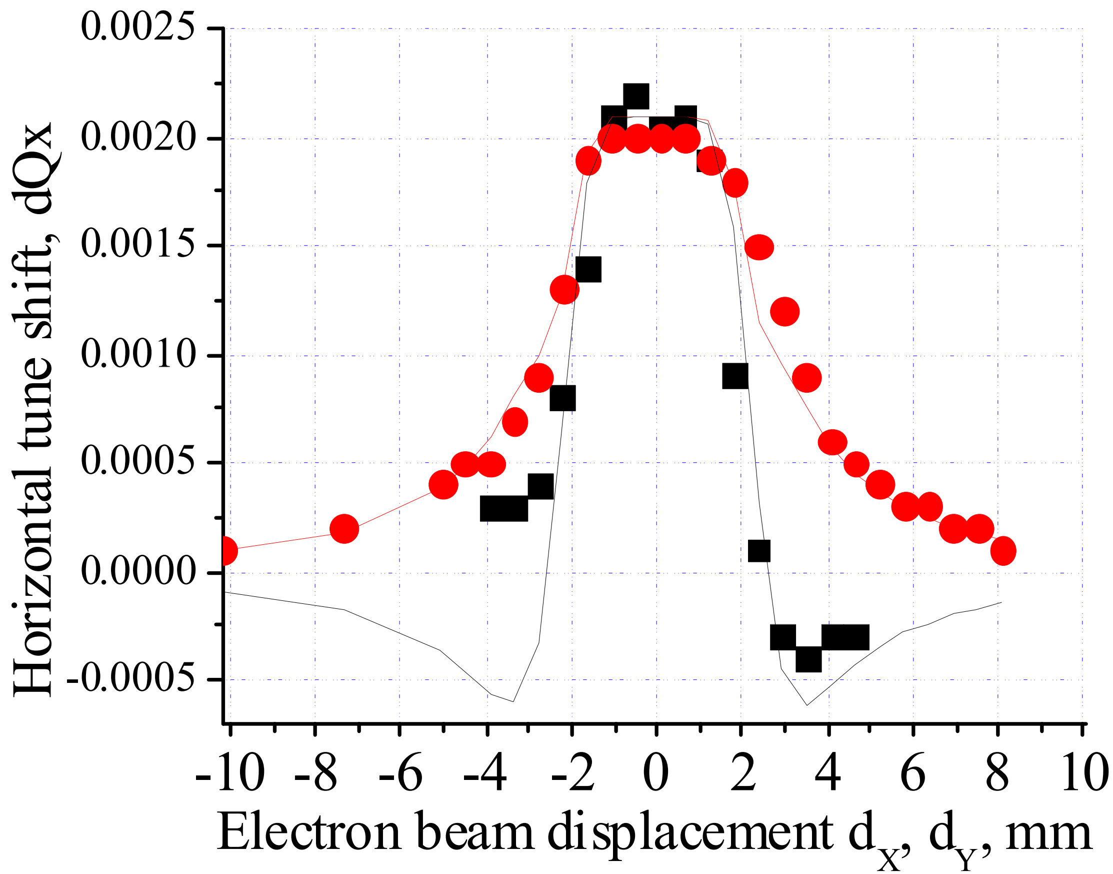
Tuneshift dQ_{hor}=+0.009



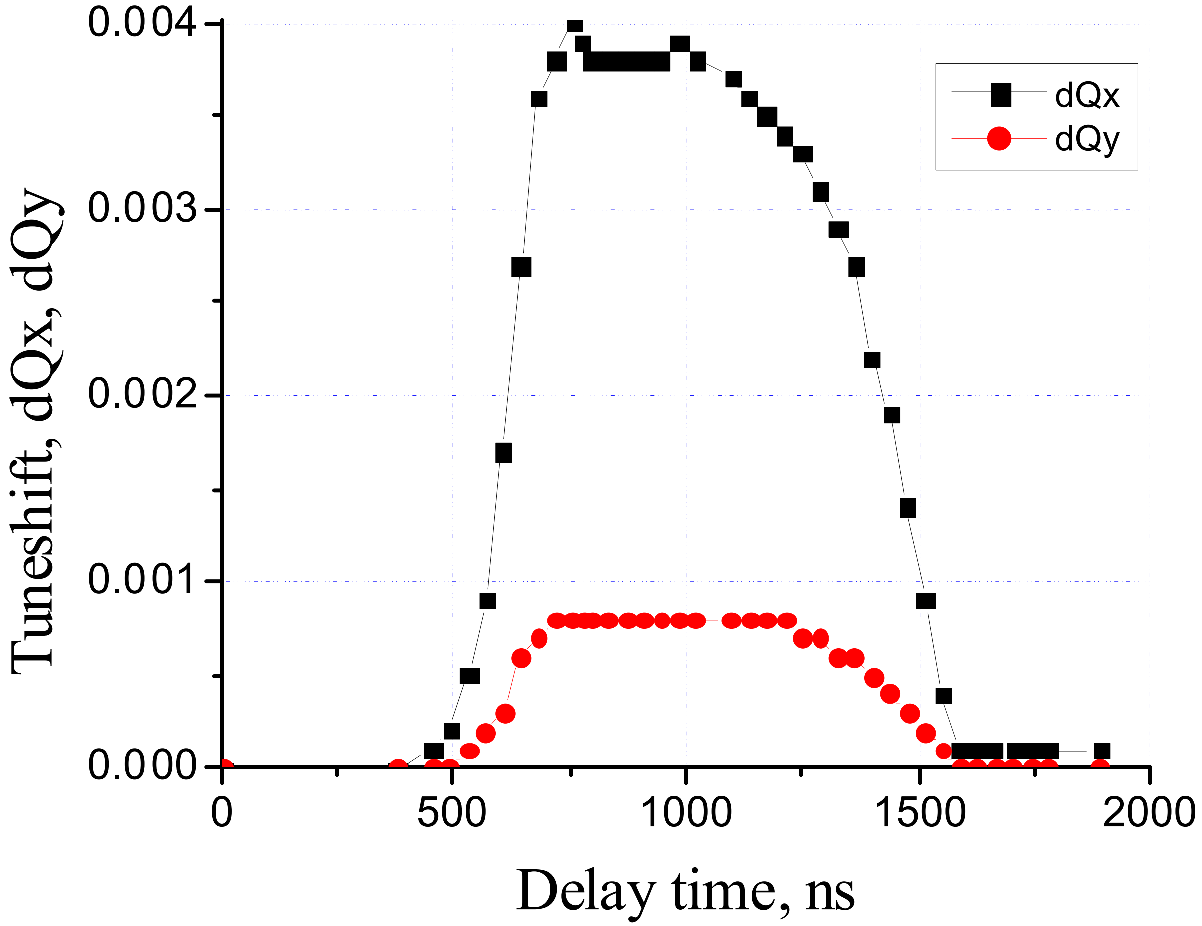
Tuneshift vs. Electron Current



Tuneshift vs. e_Beam Position

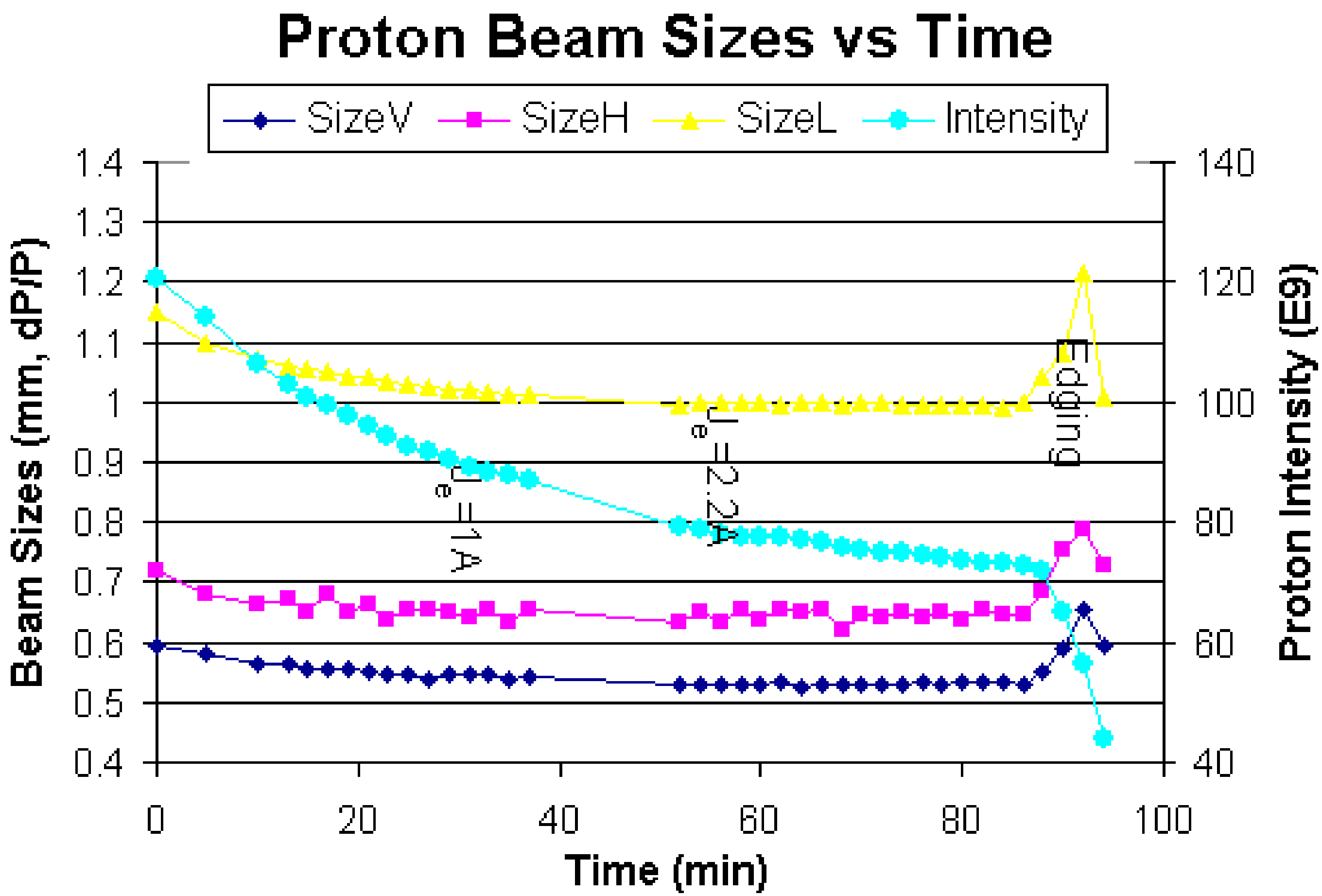


Tuneshift vs. e_Beam Timing



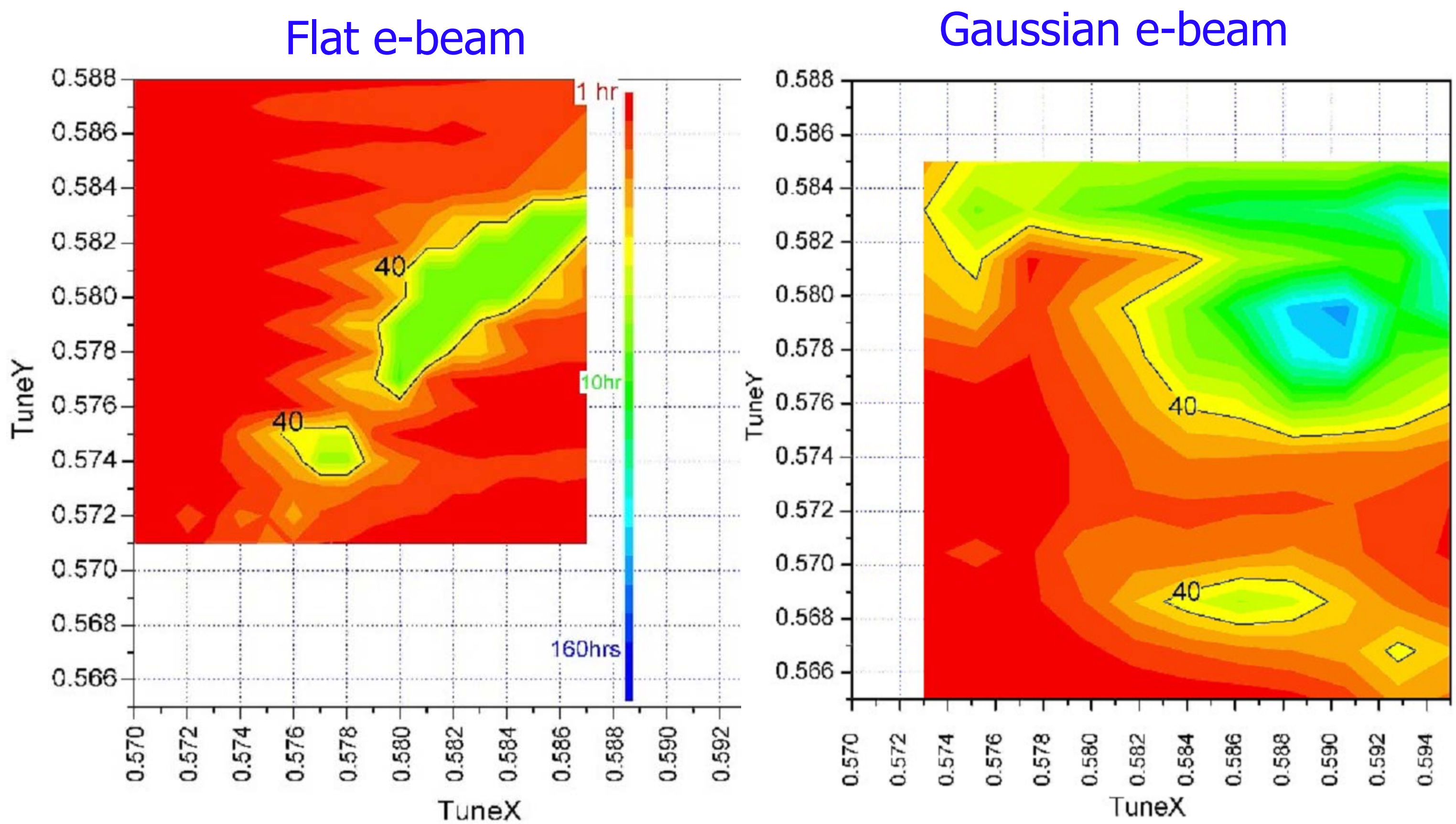
"Collimation" Effect

Need electron gun with smooth edge.

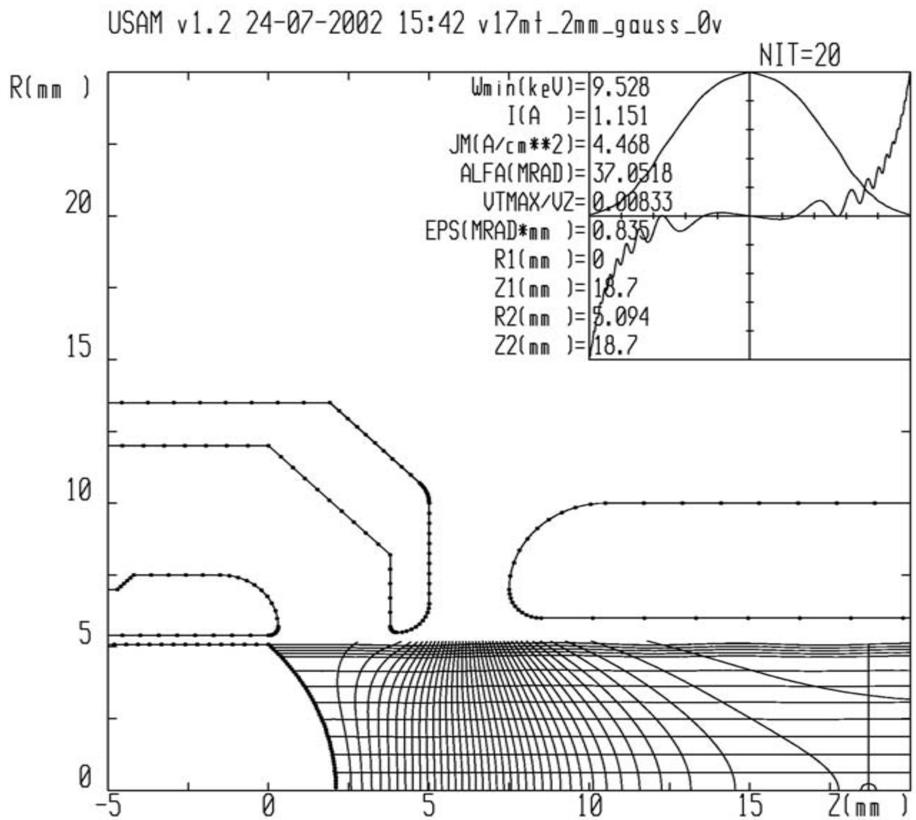


Beam Lifetime vs. Tune

With dQ_{TEL}~0.004



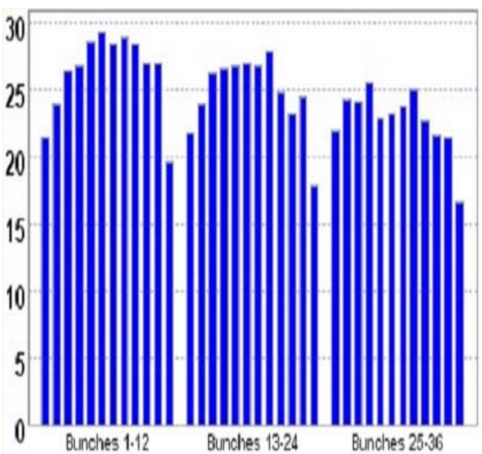
Gaussian Gun



- Beam profile controlled by special electrode
- Somewhat reduced current density in the center → need of higher voltage
- Beamsize smaller → Difficult to align the beams
- New gun: flat top with smooth edge

Beam-beam Compensation

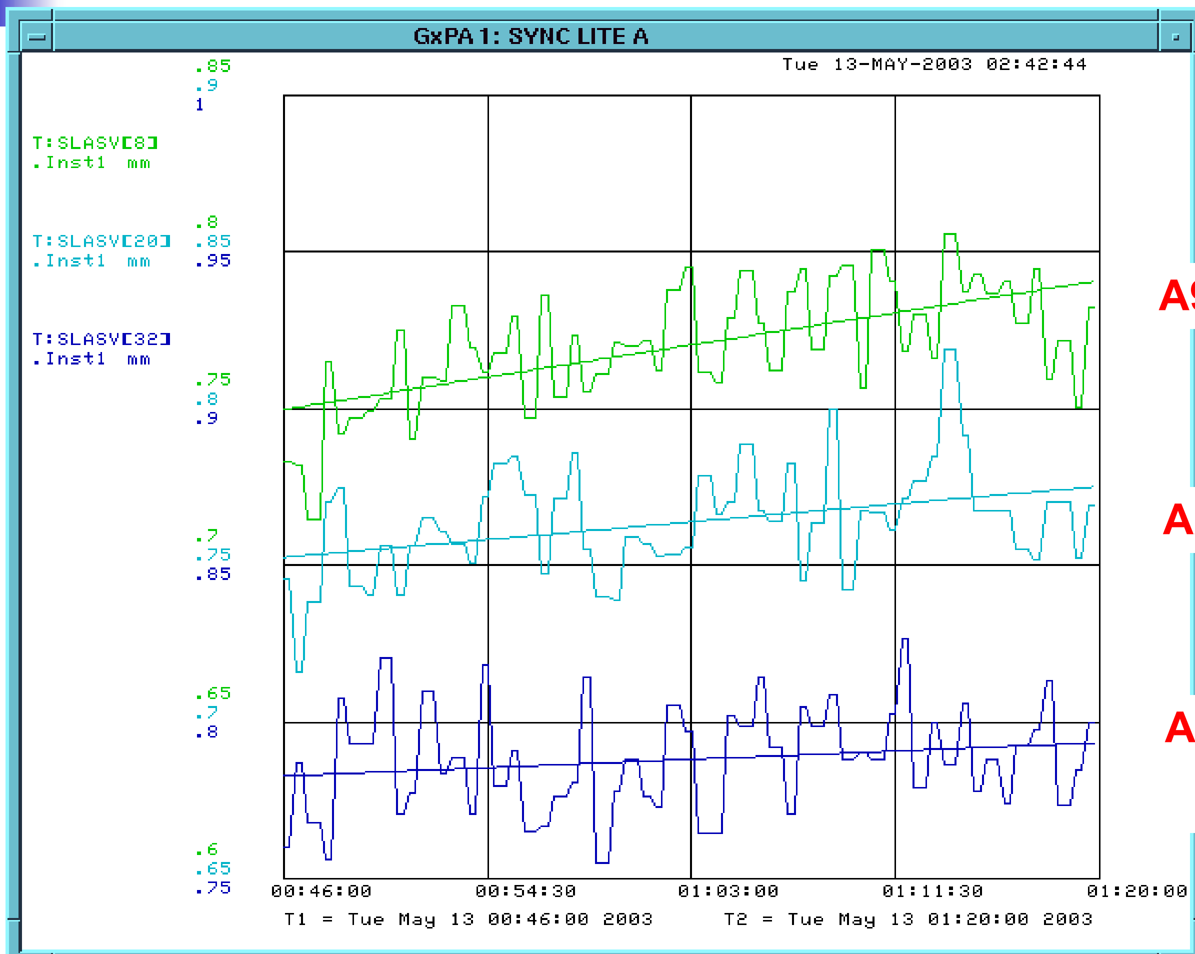
Emittance
Scallops



Emittance growth rate

STORE	#A9	#A21	#A33
#2536 (40 min)	9.9	9.2	9.3
#2538 (35 min)	1.9	1.7	2.8
#2540 (34 min)	4.1	2.2	1.0
#2546 (30 min)	3.9	1.9	4.0
#2549 (26 min)	4.5	3.6	7.1
#2551 (34 min)	6.7	6.6	7.0

Beam-Beam Compensation



Store #2540

May 12, '03

A9 : 4.1 p mm mrad/hr

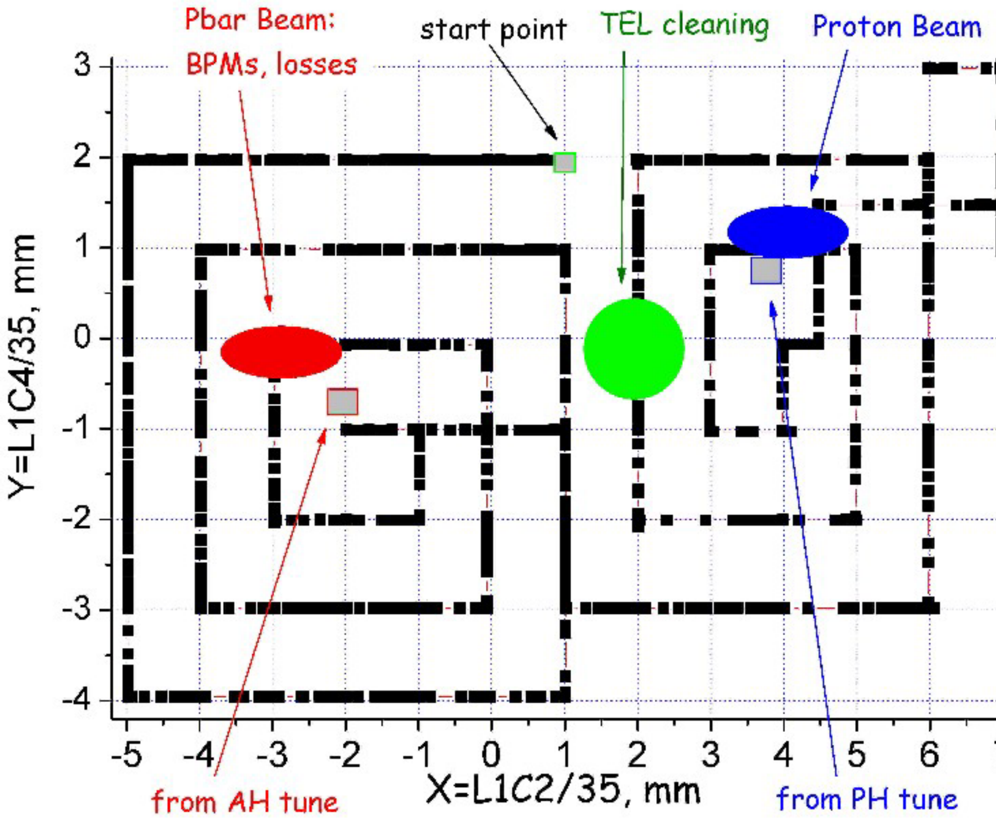
A21 : 2.2 p mm mrad/hr

A33 : 1 p mm mrad/hr

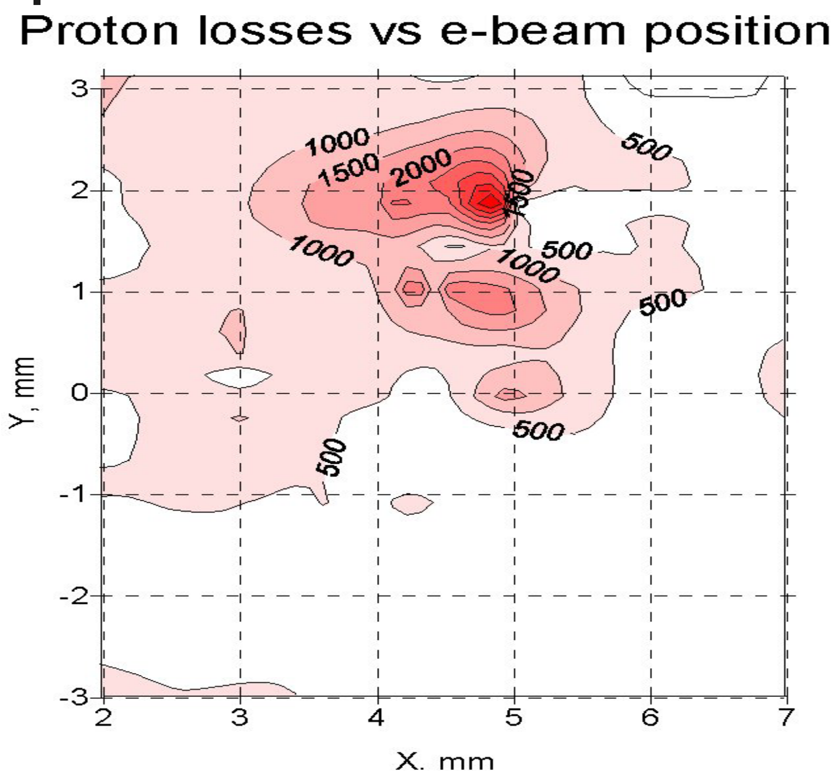
-TEL on it

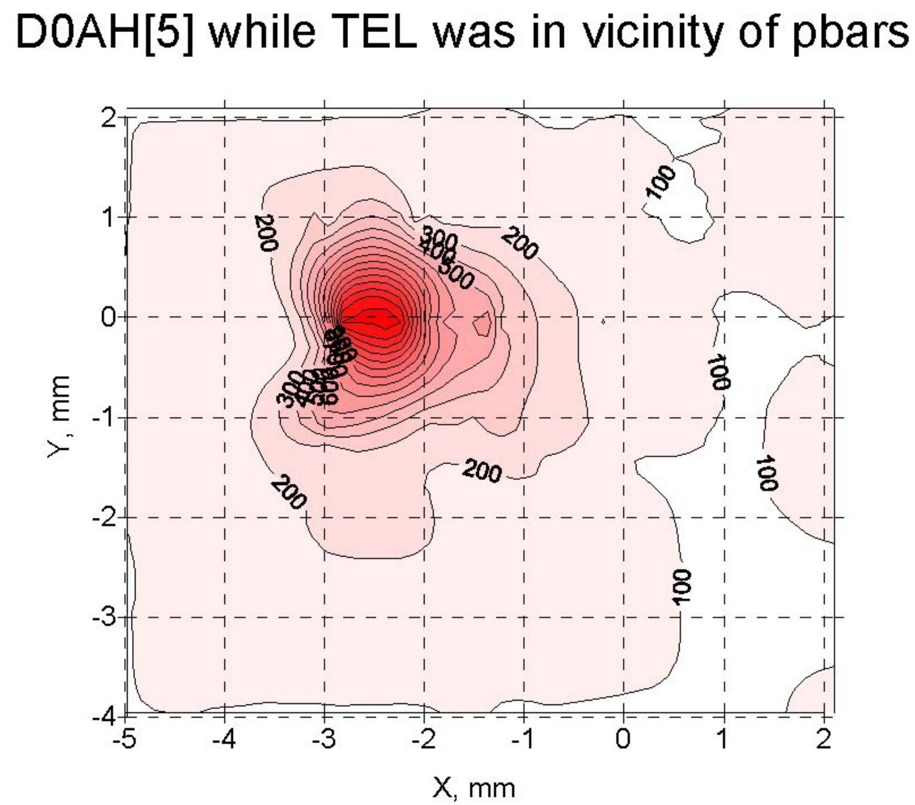
Beam Loss vs. Electron Position

- ➢ **Beam loss ~*1/R³*, *R* is distance between P/Pbar beam and e- beam.**
- ➢ **No effect on protons while e-beam acting on Pbar, and vice versa.**



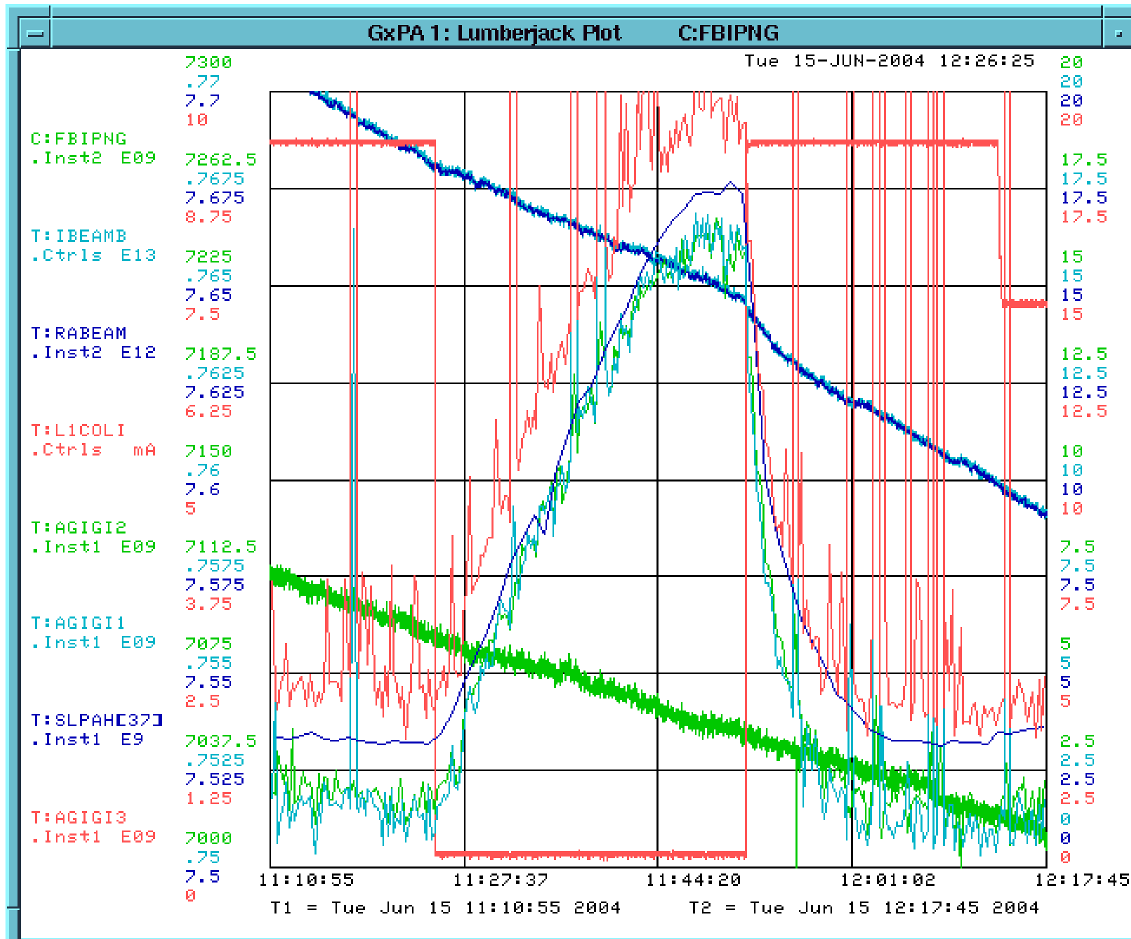
Beam Loss vs. Electron Position





Calibration of the Abort Gap Monitor

Calibration of the SL abort gap monitors: AGIGI1, AGIGI2, AGIGI3, and SLPAH[37].



Noise vs. Emittance Growth

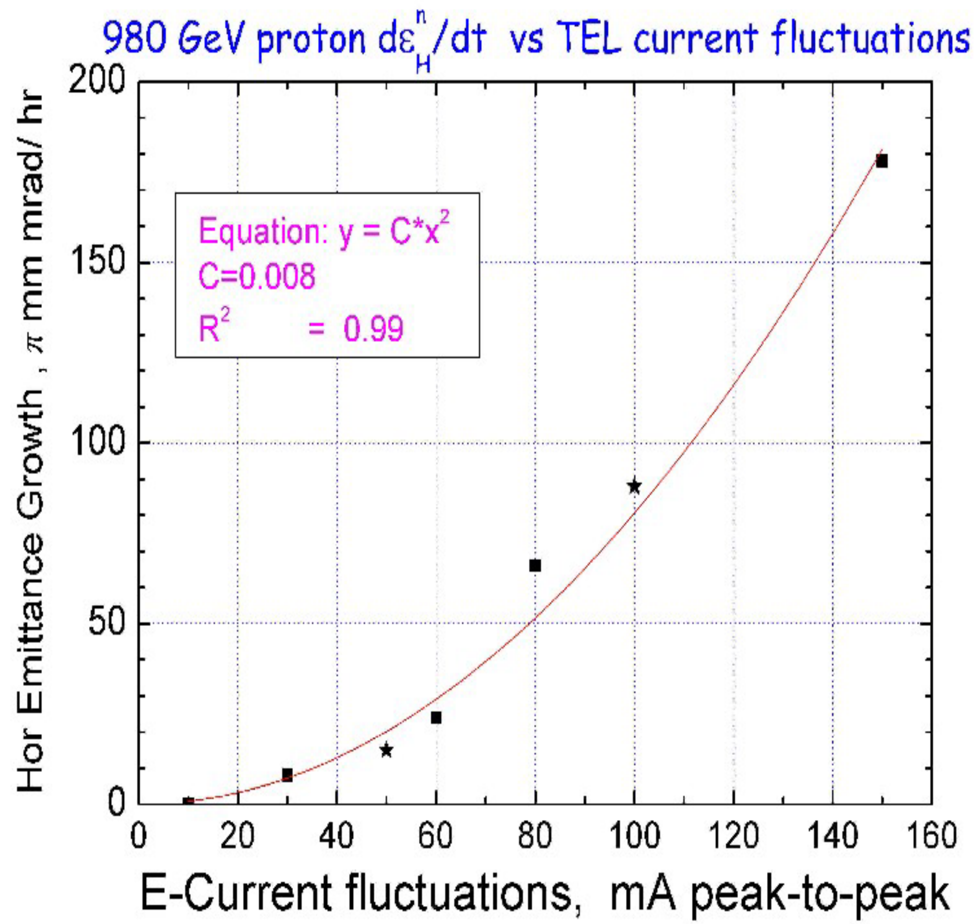
- TEL e-current turn-by-turn noise amplitude dJ_e ~3-5mA p-p

  while operating for BBC

  with dQ > 0.005

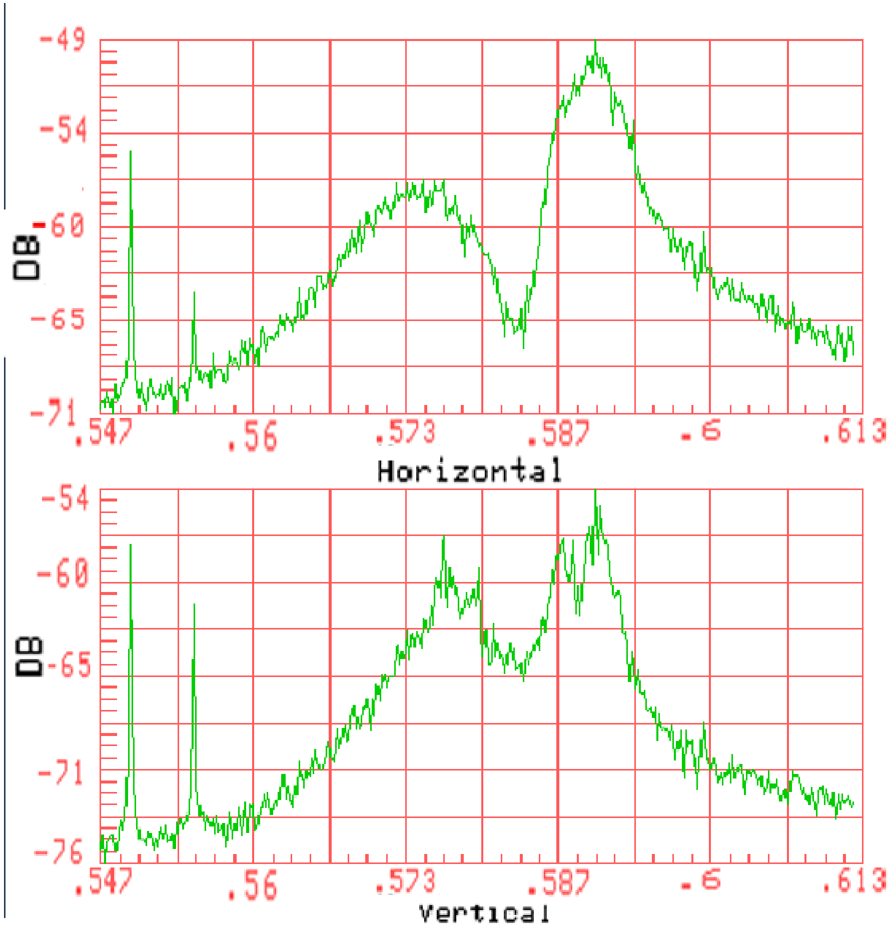
  → 0.1-0.2 p/hr

- That is less though comparable with "natural" emittance growth of 0.2-0.5 p/hr



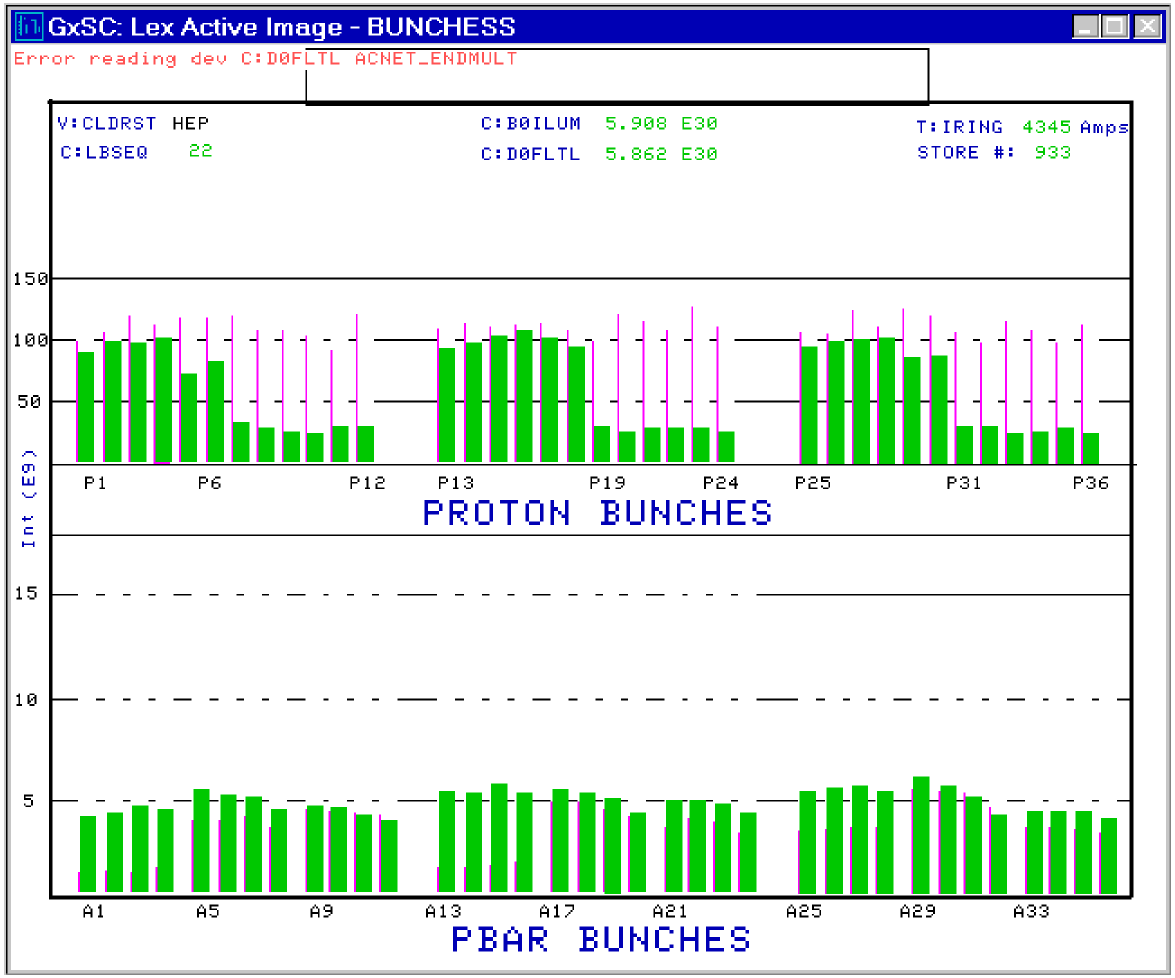
Exciting Pbar for Tune Measurment

Enable us to measure Pbar tune at the EOS by 21MHz Schottky System



P/Pbar Remover

Remove p/pbar in a controlled manner to enable the End-of-store single beam study.



Main Difficulties to Overcome

- Modulator:
  - Short pulse
  - Higher output voltage >7KV
  - Reliable, stable and no afterpulse
- BPM: need offset between e-pulse and P/Pbar bunch < 0.2mm, now ~1-1.5mm
- Resolution of bunch-by-bunch tune measurement: <0.0002 needed, 0.001~0.002 achieved; Data acquiring speed: from a few minutes (now) to a few seconds (future).

Summary

- Even though we only had limited time for with TEL1 studies, we had a lot of exciting results, found and solved some problems, identified limitations and had ideas for further upgrades.
- TEL1 is crucial for daily RunII operation.
- We have plans for the upgrades and bring TEL for beam-beam compensation. We are expecting more machine time and manpower.